

What is claimed is:

1. A current sense apparatus comprising:

an output stage connected between a high voltage and a
5 low voltage for producing a phase output current, a
mirror current proportional to the phase output
current, and a sense voltage; and

a servo amplifier for converting the mirror current to a
current sense signal.

10 2. The apparatus of claim 1, wherein the output stage
comprises:

a phase output node;

a common drain DMOSFET connected between the high
15 voltage and phase output node; and

a MOSFET connected between the low voltage and phase
output node.

20 3. The apparatus of claim 2, wherein the common drain
DMOSFET has a gate, a drain connected to the high voltage, a
source connected to the phase output node, a current mirror
terminal for providing the mirror current, and a sense terminal for
providing the sense voltage.

25 4. The apparatus of claim 1, wherein the output stage

comprises:

a phase output node;

a MOSFET connected between the high voltage and phase
output node; and

5 a common drain DMOSFET connected between the low
voltage and phase output node.

5. The apparatus of claim 4, wherein the common drain
DMOSFET has a gate, a drain connected to the phase output node, a
10 source connected to the low voltage, a current mirror terminal for
providing the mirror current, and a sense terminal for providing the
sense voltage.

6. The apparatus of claim 1, wherein the servo amplifier
15 comprises:

an operational amplifier having an inverting input
connected with the mirror current, a non-inverting
input connected with the sense voltage, and an
output; and

20 a MOSFET having a source connected with the inverting
input of the operational amplifier, a gate connected
with the output of the operational amplifier, and a
drain for providing the current sense signal.

25 7. A switching mode DC-to-DC converter for generating a

converter output voltage, the converter comprising:

one or more output stages each connected between a high voltage and a low voltage for producing a phase output current, a mirror current proportional to the phase output current, a phase output voltage and a sense voltage;

one or more servo amplifiers each for converting the mirror current to a current sense signal;

a voltage feedback circuit for comparing the converter output voltage with a reference voltage to thereby produce a voltage feedback signal;

one or more current feedback circuits each connected with the current sense signal for producing a current feedback signal; and

a control logic connected with the voltage feedback signal and one or more current feedback signals for producing a control signal to drive the one or more output stages.

8. The converter of claim 7, wherein the output stage comprises:

a phase output node for deriving the phase output voltage;

a common drain DMOSFET connected between the high voltage and phase output node; and

a MOSFET connected between the low voltage and phase output node.

9. The converter of claim 8, wherein the common drain DMOSFET has a gate, a drain connected to the high voltage, a source connected to the phase output node, a current mirror terminal for providing the mirror current, and a sense terminal for providing the sense voltage.

10. The converter of claim 7, wherein the output stage comprising:

a phase output node for deriving the phase output voltage;

a MOSFET connected between the high voltage and phase output node; and

a common drain DMOSFET connected between the low voltage and phase output node.

11. The converter of claim 10, wherein the common drain DMOSFET has a gate, a drain connected to the phase output node, a source connected to the low voltage, a current mirror terminal for providing the mirror current, and a sense terminal for providing the sense voltage.

12. The converter of claim 7, wherein the servo amplifier

comprises:

an operational amplifier having an inverting input connected with the mirror current, a non-inverting input connected with the sense voltage, and an output; and

a MOSFET having a source connected with the inverting input of the operational amplifier, a gate connected with the output of the operational amplifier, and a drain for providing the current sense signal.

13. The converter of claim 7, wherein the voltage feedback circuit comprises:

a reference voltage generator for producing the reference voltage; and

an error amplifier having a non-inverting input connected with the reference voltage and an inverting input connected with the converter output voltage for producing the voltage feedback signal.

14. The converter of claim 13, wherein the reference voltage generator comprises:

a voltage follower connected with an original reference voltage signal for producing the reference voltage;

a capacitor connected to the voltage follower for stabilizing the reference voltage; and

a resistor connected between the non-inverting input of the error amplifier and voltage follower for determining a droop of the converter output voltage.

5 15. The converter of claim 7, wherein the current feedback circuit is connected with the reference voltage.

16. A current sense method comprising the steps of:
producing a phase output current;
10 mirroring the phase output current for producing a mirror current proportional to the phase output current; and
converting the mirror current to a current sense signal.

17. The method of claim 16, further comprising the steps
15 of:

connecting a common drain DMOSFET and a MOSFET in series between a high voltage and a low voltage with a phase voltage output node between the common drain DMOSFET and MOSFET; and

20 producing the phase output current by switching the common drain DMOSFET and MOSFET.

18. The method of claim 17, further comprising providing the mirror current and a sense voltage by the common drain
25 DMOSFET.

19. The method of claim 18, wherein the step of converting the mirror current to the current sense signal comprises the steps of:

- 5 connecting the mirror current and sense voltage to an operational amplifier; and
- driving a second MOSFET by the operational amplifier for producing the current sense signal.